CLAIMS

1. A fuel processor comprising:

a primary reactor for converting a hydrocarbon-based fuel to hydrogen, carbon dioxide, carbon monoxide and water;

a water-gas-shift reactor having an inlet in fluid communication with an outlet of the primary reactor, the water-gas-shift reactor containing a catalyst that is adapted to convert at least a portion of the carbon monoxide from the primary reactor to carbon dioxide and hydrogen; and

a water adsorbent located within a flow path between the outlet of the primary reactor and an outlet of the water-gas-shift reactor, the water adsorbent generating heat during startup of the fuel processor by adsorbing at least a portion of the water from the primary reactor.

2. The fuel processor of claim 1, wherein the water adsorbent is interspersed with the water-gas-shift reactor catalyst.

3. The fuel processor of claim 1, wherein the water adsorbent has a heat of adsorption of at least about 10 kcal/mole H_2O.

4. The fuel processor of claim 1, wherein the water adsorbent has a heat of adsorption of at least about 20 kcal/mole H_2O.

5. The fuel processor of claim 1, wherein the water adsorbent is a monolith.

6. The fuel processor of claim 1, wherein:

the mass ratio of water adsorbent to water-gas-shift reactor catalyst is about 0.02 to about 0.20.

7. The fuel processor of claim 1, further comprising a source of dry gas for purging water from a void volume adjacent the water adsorbent during fuel processor shutdown.

8. The fuel processor of claim 1, further comprising:

a preferential oxidation reactor having an inlet in fluid communication with the outlet of the water-gas-shift reactor, the preferential oxidation reactor containing a catalyst that is adapted to convert at least a portion of the carbon monoxide from the water-gas-shift reactor to carbon dioxide; and

a second water adsorbent located within a flow path between the outlet of the water-gas-shift reactor and an outlet of the preferential oxidation reactor.

9. The fuel processor of claim 1, wherein the fuel processor is a part of a fuel cell engine, the fuel cell engine comprising a fuel cell stack for generating electricity from hydrogen generated by the fuel processor.

10. A fuel processor comprising:

a primary reactor for converting a hydrocarbon-based fuel to hydrogen, carbon dioxide, carbon monoxide and water;

a water-gas-shift reactor having an inlet in fluid communication with an outlet of the primary reactor, the water-gas-shift reactor containing a catalyst that is adapted to convert at least a portion of the carbon monoxide from the primary reactor to carbon dioxide and hydrogen; and

a zeolite water adsorbent located within a flow path between the outlet of the primary reactor and an outlet of the water-gas-shift reactor, the zeolite water adsorbent generating heat during startup of the fuel processor by adsorbing at least a portion of the water from the primary reactor.

11. The fuel processor of claim 10, wherein the zeolite water adsorbent has a molar ratio of silicon to aluminum less than about five.

12. The fuel processor of claim 10, wherein the zeolite water adsorbent is a type A zeolite or has FAU structure.

13. The fuel processor of claim 10, wherein the zeolite water adsorbent has a crystalline lattice in which some or all of the silicon or aluminum have been isomorphously substituted with a different element.

14. The fuel processor of claim 10, wherein the zeolite water adsorbent is interspersed with the water-gas-shift reactor catalyst.

15. The fuel processor of claim 10, wherein the zeolite water adsorbent has a heat of adsorption greater than or about equal to 10 kcal/mole H_2O.

16. The fuel processor of claim 10, wherein the zeolite water adsorbent has a heat of adsorption greater than about 20 kcal/mole H_2O.

17. The fuel processor of claim 10, wherein the zeolite water adsorbent has the form of a monolith.

18. The fuel processor of claim 10, wherein:

the mass ratio of the zeolite water adsorbent to water-gas-shift reactor catalyst is about 0.02 to 0.20.

19. The fuel processor of claim 10, further comprising a source of dry gas for purging water from a void volume adjacent the zeolite water adsorbent during fuel processor shutdown.

20. The fuel processor of claim 10, further comprising:

a preferential oxidation reactor having an inlet in fluid communication with an outlet of the water-gas-shift reactor, the preferential oxidation reactor containing a catalyst that is adapted to convert at least a portion of the carbon monoxide from the water-gas-shift reactor to carbon dioxide; and

a second water adsorbent located within a flow path between the outlet of the water-gas-shift reactor and an outlet of the preferential oxidation reactor.

21. The fuel processor of claim 10, wherein the fuel processor is a part of a fuel cell engine, the fuel cell engine comprising a fuel cell stack for generating electricity from hydrogen generated by the fuel processor.

22. A method of heating a fuel processor during startup, the fuel processor comprising a primary reactor for converting a hydrocarbon-based fuel to hydrogen, carbon dioxide, carbon monoxide and water, and a water-gas-shift reactor having an inlet in fluid communication with an outlet of the primary reactor, the water-gas-shift reactor containing a catalyst that is adapted to convert at least a portion of the carbon monoxide from the primary reactor to carbon dioxide and hydrogen, the method comprising:

providing a water adsorbent located within a flow path between the outlet of the primary reactor and an outlet of the water-gas-shift reactor, the water adsorbent generating heat during startup of the fuel processor by adsorbing at least a portion of the water from the primary reactor.

23. The method of claim 22, further comprising providing a zeolite water adsorbent.

24. The method of claim 22, further comprising purging water from a void volume adjacent the water adsorbent with a dry gas during fuel processor shutdown.

25. The method of claim 22, further comprising introducing air or oxygen into the water-gas-shift reactor to light off the catalyst.

26. The method of claim 22, further comprising:

providing a second water adsorbent located within a flow path between the outlet of the water-gas-shift reactor and an outlet of a preferential oxidation reactor.

27. A method of starting-up a fuel processor comprising a primary reactor that converts a hydrocarbon fuel to an effluent comprising hydrogen, carbon dioxide, carbon monoxide and water, and a water-gas-shift reactor having a catalyst that promotes the water-gas-shift reaction of said carbon monoxide with water to produce more hydrogen and carbon dioxide, comprising the steps of: (a) positioning a water adsorbent adjacent said; (b) flowing said effluent through said adsorbent to adsorb said water on said adsorbent and release the heat of adsorption; (c) heating said catalyst with said heat of adsorption; and (d) introducing oxygen into the heated catalyst to light-off said catalyst and commence said water-gas-shift reaction.

28. A method according to claim 27 wherein said adsorbent has a heat of adsorption of at least about 10 kcal/mole H_2O.

29. A method according to claim 27 wherein said adsorbent is upstream of said catalyst, and said heat is carried into said catalyst by said effluent.

30. A method according to claim 27 wherein said adsorbent is interspersed with said catalyst.